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Abdul Waheed

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)
email: info@merit.unu.edu | website: http://www.merit.unu.edu

Maastricht Graduate School of Governance (MGSoG)
email: info-governance@maastrichtuniversity.nl | website: http://mgsog.merit.unu.edu

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

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Employment effect of innovation: microdata evidence from Bangladesh and Pakistan

Abdul Waheed*
United Nations University (UNU-MERIT)
The Netherlands

Abstract

The analysis of the impact of innovation on employment growth is an important topic for policy makers, because (un)employment is an important social topic, and the effects of innovation on employment are often poorly understood. Despite the significant importance of this relationship, very few studies on this topic for developing countries are yet available compared with developed ones. This paper contributes to this scanty literature by investigating the employment effect of innovation for two South Asian developing countries: Bangladesh and Pakistan. We further analyze whether this relationship shows country-specific and industry-specific differences. Finally, we investigate whether complementarity between process and product innovation exists or which effect (displacement or compensation) of one particular innovation type dominates the other, in order to influence employment.

One of the striking findings of our analysis is that both product and process innovation spur employment in this region as a whole, regardless of low-tech and high-tech industries, even after controlling for a number of firm-specific characteristics. Moreover, although both innovation types also have significantly positive impacts on employment growth of all Bangladeshi and of all Pakistani firms separately, they are important factors for employment growth of only high-tech Bangladeshi firms and of only low-tech Pakistani firms. Moreover, we observe a strong complementarity between both innovation types in order to stimulate employment. Contrary to the most previous studies, we witness an insignificantly negative effect of labour cost on employment change, perhaps owing to the availability of labour force to hire at cheaper rates compared with developed countries. We notice that some of the innovation determinants exert different influences across industries and across both countries. The same is the case for the determinants of employment growth.

JEL classification: J23; O31; O33
Keywords: Bangladesh; Employment growth, Pakistan; Product innovation; Process innovation

* waheed@merit.unu.edu

1 Introduction

The impact of technological innovation on firm performance can be observed primarily in two ways: the productivity impact of innovation and the effect of innovation on employment.[1] The former is mainly an interest area of managers/industrialists, while the latter is a crucial one for policy makers. The effect of technology on firm productivity is a relatively straightforward phenomenon and often shows a positive link (Geroski, Machin, and Van Reenen 1993; Hall, Lotti, and Mairesse 2009; Koellinger 2008; Lööf and Heshmati 2006), but the relationship between innovation and employment growth is a complex one.[2] One of the reasons of this complexity is the varying channels through which both product and process innovation can affect employment growth, because although both types of innovation often coexist, the motivation and implication to have both of them in place are rather different.

One of the desired effects of product innovation is market expansion[3] of the innovator (especially when the new product is not a direct substitute of the old one), demanding more labour. On the other hand, if the innovating firm is a first-mover and launches a radically new product to the market, which is difficult to imitate for the latecomers and, moreover, if it also protects its product through some exclusive rights (e.g., patent, trademark, etc.), the innovator may operate from a monopoly position. The employment effect of product innovation then may be negative, because the monopolist may restrict output and instead raise prices. Process innovations are mostly laboursaving since they are operationalized in order to acquire more efficient production processes to obtain the same production with less (per unit) cost and labour, suggesting a negative impact of process innovation on labour demand. The cost reduction may eventually translate into price cutting, especially in a competitive environment depending on the price elasticity of demand; this may cause an increase in product demand. This demand shift would induce the firm to expand its production which entails more workforce, counterbalancing the "displacement effect" of process innovation. All in all, the expansion-related effect of product innovation (compensation effect) may dominate its "displacement effect". This might be the

[1] Innovation can affect both the quantity and quality (skill-biased technical change paradigm) of employment. The latter is beyond the scope of this study.
[2] Very good surveys of the innovation-employment relationship studies can be found in Pianta (2005), Vivarelli (2007), and Chennells and Van Reenen (1999).
[3] This expansion could be of two types: innovation could increase product demand in the same product market or could open entirely new markets for its innovator.

reason why studies generally came to an agreement on a positive impact of product innovation on employment growth (Hall, Lotti, and Mairesse 2008; Harrison et al. 2008), inter alia). However, in case of process innovation, it is hardly possible to determine unequivocally which factor dominates, which explains the empirically mixed findings of the link between process innovation and employment demand.

Whether technology creates or destroys jobs is a highly-investigated topic in the developed world, but very few studies on developing countries hitherto exist.[4] Moreover, the apparent differences among national innovation systems (NISs) of developed and developing countries and their different economic and societal paradigms assert that sources, motivations, and implications of innovation (and/or imitation) could be different between both regions. Hence, it is not justifiable to derive conclusions for developing countries on the basis of the outcomes of studies on the innovation-employment relationship for developed countries. The issue needs to be addressed in a particular context of the developing world. For developing countries, it is also important for policy purposes to investigate thoroughly what effects innovations have on employment[5]. Hence, this study is an attempt to contribute to this direction by investigating whether innovation creates or destroys jobs in developing countries.

Similar to many other developing countries, the work of Dahlman (2007) showed that South Asian countries' innovation systems suffer from many institutional problems. On the other hand, Collin (2007) argued that this region showed economic growth since the 1980s, suggesting that the region relies more on tradition production inputs than innovation in order to enhance its productivity. However, this relationship is not able to clue in the employment effect of innovation, a highly needed area of research for this region. Hence, we investigate the employment effect of innovation for two South Asian developing economies (Bangladesh and Pakistan) by using the World Bank enterprise survey conducted in 2006-07. Moreover, as Bogliacino and Pianta (2010) pointed, one of the problems of the current literature on innovation and employment is its reliance on the assumption that the employment effect of innovation

[4] One of the reasons for this scarcity is data-driven.
[5] Unemployment, of course, is a problem which developed countries can also face, and even currently some of them have higher percentages of unemployed labor force compared to developing countries. However, developed countries' policy makers can address this problem, in a short and long run, more aptly in terms of social security benefits etc. Therefore, the societal problems related to unemployment would be more probable and more significant in developing countries than developed ones.

depicts a uniform behaviour across industries, we additionally investigate this relationship for low- and high-tech industries separately, for all firm and at the country level, in order to ascertain if any disparity of employment effect of innovation exists between these sectors. In addition to that, although most of the previous studies on the innovation-employment nexus endeavoured to explicitly disentangle the effects of both process and product innovation on employment, they did not address the complementarity between them in order to influence employment demand. We also try to fill this gap in the literature by analyzing whether the effects of both product and process innovation differ if they occur in isolation compared to when they take place together. To make this point clearer, suppose that product and process innovations have significantly different impacts on employment growth (e.g., one of them has a positive and the other has a negative effect) when considering them mutually exclusive. Then the (sign and significance of) impact on employment of both of them carried out together will determine which underlying effect (laboursaving or cost reduction (passed through prices) in case of process innovation versus market expansion or tendencies to monopolistic profit in case of product innovation) dominates. Moreover, suppose that both innovation types show insignificant impacts for the former case, and we have a significantly positive effect for the latter. It will suggest that there exists complementarity between both innovation types in order to influence employment growth.

For empirical analysis, we principally follow Van Reenen's (1997) model, with some modification since he originally used it for a panel data setting, while we have a cross-sectional data set. We also expand Van Reenen’s specification by including some control variables in order to disentangle the complexity of the innovation-employment relationship more aptly. While observing the association between innovation and employment, the endogeneity of innovation could distort the findings of econometric analysis. Therefore, we take care of this endogeneity by applying the appropriate estimation methods.

In general, our results strongly favour both product and process innovation as factors behind employment growth in Pakistan and Bangladesh as a whole. However, in terms of low and high tech sectors, we observe differences across the tw**o** countries. Moreover, the effects on employment change of determinants other than innovation seem sensitive to inter-country and inter-industry differences, except for labour cost which appears to be insignificantly negative throughout, contrary to well-established notion of significantly negative effect of labour cost on employment growth.

This paper is organized as follows. Section (2) describes the empirical findings of past studies. The model is specified in section (3), while section (4) discusses the data set and descriptive statistics. The results of empirical analysis are presented in section (5) with discussion on them. Section (6) concludes the paper with some recommendations.

2 Literature review

Whether technology creates or destroys jobs is not a new topic. In the beginning of the industrial revolution in the early 18th century, it was a general fear that the induction of machinery would be detrimental to employment.[6] Ricardo (2001), in his chapter "On Machinery," retracted his previous position and argued in the same way. Further evolution of th**e** theoretical and empirical framework led the analysts to investigate the technology-employment connection more specifically, i.e., in terms of innovation-employment nexus.

The effect of innovation on employment demand involves a plethora of intricacies, which makes this relationship difficult to understand unequivocally. However, it does not seem unreasonable to believe that technological innovation generally exerts an influence on employment growth through its laboursaving (displacement effect) and/or market expansion (compensation effect) effects, but it is extremely difficult to figure out the dominance of one particular effect or the other, especially in case of process innovation because it is heavily based on the specific context in which they occur. All these complexities demand more scholarly studies in order to ascertain the innovation-employment connection thoroughly which could lead to some consensus. One of the possibilities to resolve the disagreement is to disentangle both process and product innovation and to make **a** clear distinction between them in order to investigate their impacts on employment (Edquist, Hommen, and McKelvey 2001; Smolny 1998, among others). Although the relationship is a complex one, all in all, most of the empirical studies confirmed a significantly positive influence of product innovation on employment, whereas the link between process innovation and employment is observed to be a mixed one.

[6] See Rothwell and Zegveld (1979) for a handsome amount of industry-level case studies analysing the impact of mechanization on employment.

More specifically, Mastrostefano and Pianta (2009), by using two consecutive waves of CIS (CIS2 and CIS3) for10 European countries, concluded that new products' sales share (both in levels and in percentage changes) is a significantly positive determinant of employment change, along with a positive (negative) influence of a proxy of demand (wages). In addition to that, the proportion of innovative firms (usually process innovation was dominant) has a significantly positive impact on employment change; however, the percentage change of share of innovative firms contributes nothing towards employment change. For four European countries, Harrison et al. (2008) divided the firm sales into two mutually exclusive groups: sales of new products (product innovation) and of old ones and also used a process innovation dummy. They proposed a model relating these innovation measurements to employment growth. Their general findings were in favour of a strongly positive relationship between product innovation and employment, but the effect of process innovation was not as clear as the effect of product innovation was. The study of Brouwer, Kleinknecht, and Reijnen (1993) conducted on Dutch firms asserted that R&D intensity has a negative (but insignificant) impact on employment growth between 1983 to 1988, while the effect of growth of R&D intensity for the same period is significantly negative. They further considered only product-related R&D and found a significantly positive influence on employment growth. Regarding firm-specific characteristics, the relationships between employment and sales growth (1982-1983) and between employment and firm size are significantly positive and significantly negative respectively. Freel and Robson (2004) showed that the share of technologists/scientists has a positive influence on employment growth of manufacturing firms located in Scotland and Northern England, whereas an increase in hiring professionals/managers in service firms decreases their employment growth. Moreover, product innovation significantly induces employment in both sectors (manufacturing and service); however, the effect of process innovation is clearly insignificant. The work of Antonucci and Pianta (2002) on eight major EU economies revealed that the effect on employment demand of total innovation expenditures (per sales) is negative, although mixed in terms of significance (they used it in different specifications). What general picture regarding the significance of product and process innovations, by using different definitions to proxy them, arises is that the former has a positive and the latter has a negative sign, although both are insignificant most of the time. They further calculated that a positive change of demand (proxied by the value added) induces a positive employment change, while the effect of labour cost happens to be significantly negative. By utilizing data on 31 two-digit German manufacturing firms, Ross and Zimmermann (1993) reported laboursaving technological progress as one of the significant determinants to hinder labour growth, alongside insufficient demand and labour costs. Smolny (1998), first developed a theoretical model and then applied it to West German manufacturing firms, revealed that both product and process innovations are conducive to employment. Doms, Dunne, and Roberts (1995) observed the effect of advanced manufacturing technologies (process innovations) (e.g., computer-controlled machines, lasers, robots etc.) on employment growth, from 1987 to 1991, for the United States firms, after correcting for the selectivity bias attributable to the firms' exit. Their empirical findings suggest that usage of advanced technologies and capital intensity (measures by capital-labour ratio) is significantly, positively correlated with employment growth and negatively associated with firm exit. Moreover, the results of capital intensity do not affect by the inclusion of other controls, but technology-related outcomes are sensitive to firm size. The positive effect of introduction of new technologies on employment in case of Australia and the UK can also be found in Blanchflower and Burgess (1998).

As the above review shows**,** the relationship between innovation and employment is extensively analyzed in developed economies, but we can find a very few studies for developing countries. Benavente and Lauterbach (2008) found a significantly positive impact of sales of new products (product innovation) on employment growth of Chilean firms, but the effect of process innovation appeared to be insignificant. The study of Meriküll (2010) on Estonian enterprises revealed that innovation is a significantly positive determinant of employment, when he did not make distinction between product and process innovation. He further distinguished both types of innovations and found that both product and process innovation exert a positive effect on employment, but only the impact of process innovation is a significant one. A significantly positive influence of innovative activities (R&D and patents) on employment demand of Taiwanese manufacturing firms can be found in Yang and Lin (2008). Their analysis after splitting patents into both product and process patents also depicted that both can be translated significantly into employment growth. The analysis of employment effect of innovation of Costa

Rican manufacturing firms conducted by Monge-González et al. (2011) revealed that both product and process innovation are conducive to employment growth.

3 The model specification

In this section, we propose a model to investigate the innovation-employment relationship strictly in a firm-level cross-sectional dataset. It is important first to have a look at Table (1) in order to fully understand the definitions and notations of the variables used in this section and in our empirical analysis. To some extent our model follows the specification of Van Reenen (1997) who derived a static panel data model of the labour demand as:[7]

$$\log(employmnet_{it}) = \beta_1 innovation_{it} + \beta_2 \log(wages) + \beta_3 \log(capital) + \tau_t + e_{it} \quad (1)$$

where τ_t is a vector of time dummies and e_{it} is a white noise error term. We have to modify (1) according to the cross-sectional nature of our dataset. First of all, our model does not include the term τ_t due to obvious reasons. Moreover, the panel data structure of equation (1) connotes employment at left hand side in terms of employment growth.[8] Hence, for our dependent variable, we define employment growth in a traditional way and constructed as:[9]

$$EGROWTH = \frac{employment_{2005/06} - employment_{2002/03}}{employment_{2002/03}} \quad (2)$$

Moreover, we replace fixed capital with raw material cost since our dataset have a large number of missing information for the former. Hence our employment growth model for the ith firm has the following form:

$$EGROWTH_i = \beta_0 innovation_i + \beta_1 WAGE_i + \beta_2 MATERIAL + \gamma Z_i + e_i \quad (3)$$

[7] He also used a dynamic panel structure to include lagged dependent variable. See Van Reenen (1997) for the derivation of (1).
[8] In addition to using employment in levels and with lagged dependent variable also, Van Reenen (1997) also utilized first differences which define dependent variable in terms of employment change.
[9] It is important here to note that we use only growth in permanent employment owing to unavailability of the information pertaining to temporary employment in 2002-2003.

For innovation variables, we use different measurements: PDINN, PRINN, PDPR, PDONLY, and PRONLY. In order to address the complexities of innovation-employment association more rigorously, we extend Van Reenen's model by including a vector of control variables, Z_i, with the corresponding coefficients vector γ . Our vector of control variables includes the following entries:

$$z = (LBUY ,UNION ,AGE ,TRAIN)$$

In addition to that, all our regression analyses include industry intercepts and, whenever needed, a country intercept in order to control for the heterogeneities attributable to the differences between NISs of both countries and to the different industry paradigms.

Endogeneity of the innovation variables could exist through various channels. For example, if a firm anticipates an upward demand shift, it will increase its employment and at the same time will innovate to cope with this market expansion (Van Reenen 1997). Van Reenen addressed endogeneity by instrumenting innovation variables and used their lagged values, but we have a cross-section data. Therefore, we first predict our innovation variables by using corresponding probit regressions (we have all innovation variables in qualitative forms) and use them as instruments in our employment growth equations.

4 Data and summary statistics

The World Bank investment climate survey (enterprise survey) for manufacturing firms of two developing countries (Pakistan and Bangladesh), conducted in 2006-2007, is used for empirical analysis in this paper. The dataset present the information of the firms' innovation activities (of both process and product innovation) in terms of dichotomous variables, along with a huge range of other firm-level characteristics important for our analysis.[10] After cleaning for non-responses and potential outliers, we are left with 2085 firms in total, where Bangladeshi firms comprise 62% of these. Moreover, our dataset include nine manufacturing industries aggregated at a two-

[10] The complete details of survey can be found at https://www.enterprisesurveys.org

digit level.[11] A further divide between low-tech and high-tech industries[12] reveals that we have 1715 (82%) for the former and 370 firms (18%) for the latter, suggesting that this region's industrial structure heavily depends upon low-tech sectors. The distribution of low- and high-tech industries across countries shows that among 1301 Bangladeshi firms 77% are low-tech firms, while in case of Pakistan 90%, of 784 Pakistani firms, are those which belong to this particular industrial sector. It means that, according to our sample, although the region is heavily stuffed with low-tech industries, the prevalence of low technology firms is higher in Pakistan as compared to Bangladesh.

The survey collected all pecuniary information in terms of local currency units, so to get homogeneity and to acquire easily comparable results, we convert all monetary variables in terms of a common currency unit: USD. It should be borne in mind that the value of 2085 (total firms in our sample) does not indicate that we have 2085 firms for which we have complete information for all of our variables used in the econometric analysis, but the total number of units in a certain analysis will depend upon the availability of complete information of all the variables used, which need not be a 2085.

[Please insert Table 1]

Before discussing the results, we emphasize the readers to make a clear distinction among the innovation variables we are using and going to use in our econometric analysis. Regarding the variables "product innovation" and "process innovation", we gather information for the one irrespective of the firm status with respect to other. We have three more innovation variables: "both innovations" is a variable which states that the firm carries out both product and process innovation, and two other variables "only product innovation" and "only process innovation"

[11] These industries are Food, Chemicals, Garments, Non-metallic minerals, Leather, Textiles, Machinery and equipments, Electronics, and Other manufacturing. It is important here to note that in our sample only 11 firms fall in the category of non-metallic minerals industry, and especially none of them is for Bangladesh. Therefore, for computational purposes, we merge these 11 firms with relatively broader industrial sector: other manufacturing.

[12] In order to split our sample into low- and high-tech industries, we basically follow the definition of OECD. More specifically, the industries belong to high-tech sector are Chemicals, Electronics, and Machinery and equipments, and the rest follow low-tech sector.

stating the firm status if it performs only product or only process innovation (see Table 1 for the notations and descriptions of these variables).

[Please insert Table 2]

Table (2) presents the descriptive statistics (averages) of different variables for all firms and for both Bangladesh and Pakistan separately. According to these statistics, all in all, 25% firms are reported to be product innovators, while the ratio of process innovators appears to be 31%. Moreover, we observe that, among innovators, most of the firms carry out both innovations together since almost 20% firms happen to be “both innovators”, while the fractions of “only product innovators” and “only process innovators” are observed to be 5.15% and 11.27% respectively. When we consider innovation statistics across countries, Bangladeshi firms have quite high proportion of both types of innovations compared with Pakistan: 33% vs. 12% for Product innovation and 45% vs. 10% for process innovation. Pakistan is the only case, compared with Bangladesh and with all firms, when product innovating firms are (slightly) higher than process innovators. In addition to that, the cost of labour in case of Pakistan is almost three times higher than Bangladesh while, on the other hand, employment growth of 22.54% in Bangladesh is more than double compared with the corresponding value of 10.02% for Pakistan. The above-mentioned high wage rates for Pakistan compared with Bangladesh might be one of the reasons of its relatively slow employment growth (a highly reported determinant in the literature which analyses the factors that hinder employment growth). Moreover, cost of raw material appears to be almost double for Pakistan than for Bangladesh, suggesting perhaps its substitutability, rather than complementarity, with employment, especially for Pakistan. The average permanent employment for Bangladesh is 264.39, which is considerably higher as compared to the average employment of 90.38 for Pakistan. On the other hand, the average net book values show that Pakistani firms have an average of $28.94 thousand, while the corresponding value for Bangladesh is $5.93 thousand. The descriptive statistics regarding human capital (employment and employment growth) and financial capital (raw material cost and net book value) reveals that Bangladeshi firms are more human capital-intensive, whereas Pakistani firms are far ahead for the latter. Regarding other firm-specific characteristics used in our analysis, 52% Bangladeshi firms are reported to purchase fixed assets, while only 18% Pakistani firms appears to engage in this kind of purchase. The percentage of firms using web, having workers’ union, running formal training programs, and having large buyers are also higher for Bangladesh as compared to Pakistan, with relatively lesser disparities for the first two indicators than the last two factors.

[Please insert Table 3]

Table (3) reports the descriptive statistics for low- and high-tech industries separately, for all firms and across the countries. For all firms taken together, both “product innovation” and “process innovation” occur more often in the high-tech than low-tech sector. The result remains the same if we consider the firms which report to have “both innovations”; however, the outcomes are reversed in case of “only product innovation” and “only process innovation”. These results suggest that the complementarity between both types of innovations is more pivotal in high-tech compared with low-tech industries. Wages are almost the same for both industrial sectors, whereas firm age, material cost, and employment growth are higher in high-tech as compared to low-tech ones. Regarding fixed asset purchase and internet usage, high-tech sector again has higher percentages, while the occurrence of workers’ union does not have substantially different ratios for both types of industrial sectors. The descriptive statistics reveal that 28% high-tech firms run formal training programs, which is almost double than the percentages of low-tech firms, whereas the results for large buyers show the opposite: almost 20% low-tech and almost 10% high-tech firms have large buyer with more than 100 employees. The last four columns of Table (3) depict these descriptive statistics with particular reference to both countries. For innovation-related variables, the results reveal almost the same pattern as we have observed for all firms, except for “only process innovation” for Pakistan, showing slightly higher, though very modest, proportion of innovators in high-tech as compared to low-tech sector. In addition, wages are higher and firms are older in Bangladeshi high-tech industries than its low-tech firms. The statistics on both of these variables show that they are almost similar for both sectors in Pakistan. Cost of raw material is higher in the group of high-tech industries for both countries; however difference is very wide for Pakistan compared to Bangladesh. In case of all Pakistani and Bangladeshi firms are taken together, we have noted that employment growth is slightly higher in high technology firms, but the corresponding point estimates across countries disclose that both sectors have almost same employment growth in Bangladesh, whereas Pakistani high-tech sector has slightly larger employment growth.

5 Microeconometric analysis

As mentioned already, we use predicted values of the innovation variables as instruments in the employment growth equations in order to avoid endogeneity problems. These predicted values are obtained from probit regressions for innovations. We calculate predicted values which are used in their corresponding employment equations. For instance, for the employment equation of low-tech industries of Pakistan, we compute the predicted values for the same group and so on.

5.1 Determinants of innovation

Although the primary objective of the probit regressions is to obtain innovation instruments, the results are helpful to acquire insight into the innovation determinants in this region as well.

[Please insert Table 4]

Table (4) shows the results of probit regressions of both types of innovations separately, for all firms and with and without splitting the dataset into low-tech and high-tech industries. For all firms taken together, it is observed that firm size (sales) appears to be an insignificant determinant of product innovation and a significantly positive factor of process innovation. Usage of web (could be a proxy of a firm's more dynamic exposure, especially in developing countries like ours), purchase of fixed assets, and whether or not the firm is located in an industrial zone are significantly positive indicators of both types of innovations. Moreover, older firms are less product and process innovators compared with younger ones. Our results also disclose that an increase in the production workers ratio results in a decrease of the likelihood of product innovation. The production workers are, in principle, hired for production purposes, not for innovation. The relative increase in production workers implies a relative decrease in non-production workers, e.g., administrators, managers, R&D personnel, etc., which are typically more responsible for innovation. Hence, the results suggest that a decrease in these non-production workers intuitively reduces the chances of product innovation. However, production workers intensity has an insignificantly negative impact on the occurrence of process innovation. The demand side variable (LBUY)[13] does not contribute to either product or process innovation.

[13] Of course, our variable LBUY does not capture the "demand-pull" indicator particularly used in the innovation literature. So, we cannot interpret the results of LBUY as an innovation effect of demand-pull.

Recall that the descriptive statistics showed that Pakistani firms are less often innovators compared with Bangladeshi ones, and this is confirmed econometrically since we obtain statistically significant negative signs of the associated coefficients of the Pakistan dummy (PAK), for both types of innovations. Our further split into low and high technology firms reveals some interesting features. First of all, the findings of low-tech sector follow exactly the same pattern as we discussed above with the context of all firms, except for one case: PRODIN is a modestly significant predictor to decrease low-tech firms' process innovation, in addition to its negative impact on low-tech product innovation. Moreover, contrary to an almost similar pattern for the last two cases, we notice differences in case of high-tech firms. Recall that firm size (sales) does not contribute to low-tech firms' product innovation, but it is an important determinant in case of high-tech industries. One of the possibilities of this difference could be that high-tech firms are more R&D-intensive by definition, and it is generally believed that R&D induces innovation and large firms have more formal R&D activities (through their R&D departments). So, there is a possibility that large firms' formal R&D translates more aptly into product innovations as compared to small firms' R&D activities. Moreover, similar to low technology industries, firm size encourages process innovation. The results of WEB, ASSET, and INDZONE follow exactly the same pattern in low and high technology sectors, showing significantly positive effects of these indicators on both types of innovations. The negative significance of PRODIN for low-tech industries disappears in high technology sector, although the coefficient for product innovation still has a negative sign. It means that the previously found effect of the production workers ratio is not as much intensive in case of high-tech as it is in low-tech sector. Furthermore, a significantly negative impact of firm age on both product and process innovation for low-tech firms also disappears for a group of high-tech firms, meaning that technology-intensive characteristics of high-tech sector compel old firms also to innovate in order to hedge the risk of their market power/profit losses exerted by their young rivals through novelties. Large buyers appear to be an influential determinant of high-tech firms' process innovation, whereas these have no impact on their product innovation.

[Please insert Table 5]

The results of probit regressions on PDINN and PRINN for all Bangladeshi firms and for low and high technology Bangladeshi firms are depicted in Table (5). In case of all Bangladeshi firms, most of the results are similar to those that are obtained for all Bangladeshi and Pakistani firms taken together (compare first two columns of Table 4 with respective columns of Table 5). We do not discuss the similar findings here but shed some light on the disparities: the ratio of production workers in total permanent employment now happens to be insignificant as an indicator of product innovation and the insignificance of large buyers as a determinant of product innovation vanishes, and it appears to be a significantly discouraging factor now. If we further compare the first two columns of Table 5 (all Bangladeshi firms) with the next two columns of Table 5 (low-tech Bangladeshi firms), we notice that the performances, with respect to sign and statistical significance, of all determinants of both innovation types of all Bangladeshi firms (column 1 and 2 of Table 5) are identical compared with their corresponding performances for low technology Bangladeshi firms (column 3 and 4 of Table 5). Similar to the full dataset (Table 4), we discover some differences between the outcomes of high-tech and low-tech industries (and of all Bangladeshi firms). Contrary to low-tech Bangladeshi firms and similar to all high-tech firms, firm size (sales) is helpful to increase the likelihood of product innovation. According to our analysis, WEB, ASSET, and INDZONE are conducive to enhance the chance of both types of innovation activities held by both low and high technology Bangladeshi firms, showing that the results of these three determinants are similar to those that are observed in case of large low-tech and high-tech pools of both Bangladeshi and Pakistani firms. In addition, firm age's significantly negative influence on low-tech innovations dissipates in high-tech tech sector, though the signs of coefficients are still negative. We notice that in all and in low-tech Bangladeshi firms, large buyers exert a negative impact on product innovation, but their relationship with process innovation is statistically insignificant. However, in case of high-tech industrial sector large buyers' negative influence on product innovation loses its significance, and they also do not induce high-tech firms to carry out process innovation (similar to low-tech sector). Our interpretation is that a firm primarily sells product, rather than process, to its buyers and large buyers would be an important source to magnify its product demand. And the results show that this relatively large demand, in comparison with small buyers' demands, is perhaps mostly non-innovating, especially in low-tech industries because of the nature of this sector, which discourages firms to carry out product innovation in this sector. However, in high-tech sector, buyers' demand is relatively less non-innovating in nature and at least does not discourage product innovation in this sector.

[Please insert Table 6]

In a similar fashion as Table (4) and (5), the empirical findings of Pakistani firms are reported in Table (6). Comparison of these results with Bangladesh unveils some interesting contradictions. The results fail to find a significantly positive relationship between firm size (sales) and both innovation types for all Pakistani firms and for both low- and high-tech Pakistani industries, except for a very slight significance in case of low-tech process innovation. Similar to Bangladesh, the significance of ASSET as an explanatory factor of both innovations is established for all Pakistani firms and for low-tech Pakistani industries but, contrary to Bangladesh, Pakistani high-tech firms' purchase of fixed asset does not contribute to their innovations (both product and process). Throughout the results of Bangladesh, PRODIN appears to be an unimportant factor of both types of innovations, but we observe that it substantially decreases the likelihoods of high-tech Pakistani firms' product and process innovation. Usage of web has a positive influence on PDINN and PRINN, for all cases (i.e., all and low and high technology Pakistani firms). The empirical findings of Bangladesh reveal that its firms located in certain industrial zone enjoy the benefits of more formally embedded infrastructure over there and translate it into their product and process innovation, regardless of the industrial sector they belong to. However, in case of Pakistan this particular variable induces innovations only in the high-tech sector. Another contradiction is that throughout Table (5) firm age appears to be an inconsequential determinant of both product and process innovation. Finally, contrary to Bangladesh, large buyers (possible proxy of firm demand) are encouraging source of both types of innovations of Pakistani firms, whether they are low-tech or high-tech.

5.2 Innovation as a determinant of employment growth

The primary objective of this paper is to investigate the innovation-employment connection. Before going further, it is worthwhile to note that, especially for comparison purposes, our dependent variable is employment change of permanent employees instead of employment change of all labour force since our data set do not have information for the latter. However, we argue that our results might be more robust (less volatile) because innovation is a long term process which entails labour force on a permanent basis in order to carry out and take care of innovative activities of a firm or which persuade to fire some permanent labour force because it is worthless after innovation. We do not completely discard the fact that innovation could generate/destroy temporary employment, but we believe that this effect would be significantly lower than the effect on permanent employment. Most of our employment equation results, which we will discuss subsequently, show significantly well goodness of fit.

[Please insert Table 7]

Table (7) depicts the regression results of the analysis of employment growth determinants of all firms (both Pakistan and Bangladesh), for the full sample and for the low- and high-tech sector separately. It is important to convey that we first insert (predicted values of) both PDINN and PRINN in a single employment equation and test for multicollinearity, which is indeed observed at a significant level. [14] Hence, we enter these variables in separate employment equations in order to avoid the collinearity. If we consider all firms, one of the striking results is that both types of innovations have a significantly positive influence on employment growth, even after controlling for a number of firm-specific characteristics. Moreover, the coefficients of cost of both raw material and wages have negative signs, but significance is achieved only for the former, especially when employment equation includes process innovation (PRINN-included). The literature often argues that an increase in firm product demand translates into an increase in employment (Pianta 2001; Ross and Zimmermann 1993). Our demand side variable (LBUY), although is not a direct indicator of firm demand but instead has the connotation that the large buyers have more demand to buy than the small ones, also shows a significantly positive influence on employment change. A negative relationship of employment growth with firm age and with unionism was found by Variyam and Kraybill (1992) and by Blanchflower, Millward, and Oswald (1991) respectively. Long (1993), for Canadian firms, and Leonard (1992), for Californian manufacturing plants, also observed that these predictors hinder employment growth, especially in a significant way in large firms. According to our results, it also appears that firm age and workers' union reduce employment growth. The possible reasons might be that a

[14] It is often observed that both types of innovations carry out simultaneously, and one of the primary reasons of this collinearity here also is that both PDINN and PRINN are predicted values obtained from the same model specification.

younger firm introduces new products by definition and needs a continuous increase in its labour force in order to meet the market requirements of the product growth phase of its product life cycle until the maturity level, followed by the decline and in turn destruction of jobs related to this product. The reason of a negative impact of unionization on employment growth could be that a firm's workers primarily take care of their own interest and have a fear of their job losses and/or at least wage losses led by the hiring of new employees, thereby exerting pressure through their union to discourage job creation. On the other hand, strict labour laws (high wages, job security, huge severance expenditures etc.) attributable to the union bargaining lead a firm to be hesitant to increase employment.[15] The results of formal training show that it does not contribute to employment growth, contrary to the findings of Cosh, Hughes, and Weeks (2000) who empirically found a positive effect of training on employment growth. Finally, the coefficients of the Pakistan dummy for both product and process innovation are negative but standard errors does not allow us to find them significant, meaning that in terms of employment change there is no substantial difference between Pakistan and Bangladesh, although descriptive statistics have shown that employment growth is substantially higher in Bangladesh.[16]

A further analysis with respect to low- and high-tech firms shows that both innovation types are again significantly positive predictors of employment growth for both industrial sectors. The results of wages and training do not vary between industrial sectors, and also follow the pattern of all firms taken together. According to the results, negative influences of raw material and union status show some significance in low-tech firms which disappears for high-tech firms. The findings of large buyers and firm age in low-tech sector are also different from those of high-tech sector: large buyer is a significantly positive and age is a significantly negative predictor of low-tech firms' employment change, but both are insignificant in case of high-tech sector, although age still exerts a negative influence. The general picture that emerges is that, for both countries together, innovation induces employment regardless of industrial sectors and many other

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[15] See Long (1993) for a number of arguments arguably shapes the union-employment relationship.

[16] There could be two possible interpretations of this contradiction. We can argue that higher employment growth of Bangladesh, compared with Pakistan, asserted by descriptive statistics are not actually attributable to the geographical location of the firms but some other forces explain this difference. Secondly, recall that the Pakistan dummy enters in innovation equations with a huge negative effects on innovations and this already included negative influences in predicted values of innovations undermine its negative effect here in employment equation. We explore this argument empirically by excluding innovations from employment equations (results are not reported) and surprisingly observe a significantly negative effect of the Pakistan dummy (PAK) in all cases (all firm and low- and high-tech firms separately).

determinants of employment change are heavily influenced by the industrial sector-specific characteristics.

[Please insert Table 8]

In a similar way as all firms, results of separate analysis of Bangladeshi firms are shown in Table (8). Both innovation types again appear to be important indicators of employment growth in all and high-tech Bangladeshi firms, but they lose their significance for low-tech firms (although signs are still positive and magnitudes of coefficients are reasonably high). Throughout the regressions for Bangladesh (Table 8), raw material, wage cost, and union status do not contribute towards employment change. For all Bangladeshi firms, again large buyers stimulate employment and firm age impedes it, in addition to formal training which also shows a negative effect on employment growth. When we consider the last three reported employment determinants in low- and high-tech sector, we observe interesting differences. Large buyers and firms age respectively encourage and discourage low-tech firms' employment growth, whereas they have no influence on high technology firms' employment change, although the coefficient signs are same. On the other hand, (a dummy of) formal training shows a significantly negative influence for high-tech and an insignificant impact on low-tech employment change.

[Please insert Table 9]

The findings for Pakistani firms are reported in Table (9). Similar to previously observed findings of both countries together and of Bangladeshi firms only, both product and process innovation again appear to be conducive and important determinants of employment change of all Pakistani firms. However, we witness some contradictions between both countries regarding industrial sectors: both innovation types are significant (insignificant) determinants of low-tech (high-tech) Pakistani firms' employment change, exactly opposite to the results of Bangladesh. It means that the role of innovation in order to observe its impact on industry-specific employment change heavily depends on their respective national innovation systems (NISs), but inter-country differences are less important when we consider employment effect of innovation as a whole. For all Pakistani firms taken together, the results disclose that those Pakistani firms which have relatively more material cost exhibits less employment growth, meaning that in Pakistan a strong substitutability, rather than a complementarity, between human capital and raw material exists. This variable also shows a negative effect on low-tech firms' employment but is insignificant for high-tech. Throughout the Table (9) wages again do not contribute towards employment change. Surprisingly, in all cases large buyers (our crude proxy of product demand) are unable to stimulate employment, though most of the time signs are positive. One reason might be that percentage of large buyers in Pakistan is only 7.48, which is quite low compared to 23.86% in case of Bangladesh, suggesting that Pakistani firms have a low product demand than Bangladeshi ones at aggregate level. The previously observed negative effect of firm age, especially for all and low-tech firms, disappears and it becomes an insignificant predictor throughout the table which reports Pakistan's results. Contrary to Bangladesh, firms which have unions show significantly less employment growth than those which have a non-union workforce, in case of all firms taken together and of low-tech industries. However, an earlier noted insignificant relationship between union and employment growth in Bangladeshi high-tech firms is also hold for the corresponding group of Pakistan. We also notice a contradiction between the impacts of formal training on employment growth. In all Pakistan cases (all firms and low- and high-tech sector) training is an inconsequential predictor of employment growth.

In all our regressions of both countries taken together and when considering them separately, a negative influence of wages on employment growth is found, but we are unable to achieve significance of this relationship, contrary to the outcomes of previous studies. The reason might be that our regressions also include unionism as an explanatory variable which shows a significantly negative influence on employment changes, especially for all firms' regressions and for Pakistani firm's regressions separately. And the negative effect of high labour cost (salaries, bonuses, and allowances etc., which are included in our wage variable) is captured by this variable,[17] which undermines the negative effect of the variable labour wages. Hence, we explore it and observe that our both variables (union status and wages cost) do not suffer from the problem of multicollinearity. Having said that, in order to become more certain, we run another set of regressions by excluding unionism (results are not reported) and find no differences. It

[17] Recall the previously discussed channels through which unionism could hinder the employment growth.

suggests that an insignificantly negative effect of labour cost is a true phenomenon in our data set.

5.3 Complementarity between process and product innovation

So far we use one particular innovation type regardless of status of a firm with respect to other innovation.[18] We now move further to another important purpose of our paper and define three new innovation variables in order to find whether complementarity between both innovation types exists or which effect (displacement or compensation) of one particular innovation type dominates the other. Our newly defined variables are PDPR (firms have both product and process innovation), PDONLY (firms carry out only product innovation), and PRONLY (firms do only process innovation). We run the same specification by including these new innovation definitions,[19] but we discuss only innovation results since scope of these regressions is to ascertain the above stated phenomenon, and also the results of all other variables do not differ substantially between both sets of regressions (the previously discussed and the coming ones).

[Please insert Table 10]

Table (10) reports the results for both countries' firms taken together. If we consider all firms, both PDONLY and PRONLY are insignificant determinants (with positive signs) of employment growth, but the variable "both product and process innovation" appears to be a positively significant predictor of employment change, suggesting the complementarity between both types of innovation in order to stimulate employment. The results are the same for both low-tech and high-tech sector.

[Please insert Table 11]

[Please insert Table 12]

Table (11) and (12) disclose the outcomes for Bangladesh and Pakistan. In case of all and high-tech Bangladeshi firms, we again notice a complementarity between product and process

[18] For example, if we say a firm is a product innovator, we do not consider whether it is a process innovator or not.

[19] We again use predicted values of these innovation variables which are obtained by running the corresponding probit regressions of these variables using the same model specifications as previous probit regressions. However, we do not report the results in order to conserve space.

innovation. For low-tech Bangladeshi firms, both PDONLY and PRNLY are insignificantly negative predictors of employment change; PDPR is also an insignificant regressor but the associated coefficient has a positive sign. This might again suggest a complementarity but at a lesser intensity. The results of Pakistani firms also reveal that both “only product innovation” and “only process innovation” do not contribute to employment growth, but those firms that carry out both innovations together show a significantly higher employment growth. Hence, our results strongly advocate the complementarity between process and product innovation to have a positive impact on employment growth.

Note that we cannot report the results of high-tech Pakistani firms because only 2 out of 76 firms are reported to carry out “only product innovation”, and the similar number is for “only process innovation”. These extremely low numbers do not allow most of the explanatory variables to predict these variables in order to use as instruments in employment equation.

6 Conclusions and policy discussion

Despite a paramount need for policy purposes to know whether innovation is helpful or detrimental to job creation in developing countries, very few studies tried to explore this relationship. This paper is an attempt to contribute to this direction by using two developing countries: Pakistan and Bangladesh. Moreover, we observe if any differences of this relationship across countries and across low-tech and high-tech industries exist. We also ask whether complementarity between process and product innovation in order to induce and/or detriment employment growth exists or which effect (displacement or compensation) of one particular innovation type dominates the other. In our empirical analysis, we take care of the endogeneity of innovation in employment equation by using its predicted values as an instrument.

Firm size (sales) appears to be an important determinant to induce process innovation in our region of analysis as a whole and for Bangladesh; however, it has a very modest (almost no) effect in case of Pakistan. Moreover, in case of product innovation, Schumpeter hypothesis of favour of large firms fails to accept as a whole and across countries as well. An insignificant effect of product innovation in case of Pakistan does not appear to be industry-specific, while in other cases (both countries together and Bangladesh) high-tech firms’ sales induces their product innovation, suggesting perhaps the complementarity between large firm size and R&D activities (high-tech firms are more R&D-intensive by definition) in order to induce product innovation. We find some evidence of a negative effect of production workers' intensity on innovation, especially on product innovation, except for the high-tech sector. Our interpretation is that a relative decrease in non-production workers (typically responsible for innovation as compared to production workers) implies a relative decrease of innovation activities. According to our results, the performances of innovation determinants show some disparities across low and high technology sectors and also across both countries, which seems to be more pivotal for the latter. One straightforward conclusion appears from our analysis is that Bangladeshi firms are more often innovators than Pakistani ones.

One of the striking results of our innovation-employment analysis is that innovation (both product and process) encourages employment growth, even after controlling for a number of firm specific characteristics. It means that in this particular region "compensation effect" of innovation dominates its "displacement effect". For product innovation, these results are in line with the literature. In case of process innovation, our results corroborate the argument of those who assert a positive effect of process innovation on employment growth instead of its negative influence, even perhaps more dominant one is the latter but our empirical analysis follow the former. It means that in this region the short-term displacement effect of laboursaving characteristics of process innovation is weak as compared to the long-term compensation effect through price reduction and in turn demands expansion. Moreover, these positive effects of both innovation types are not affected by geographical locations of firms because they remain significantly positive across countries. Innovation is conducive to employment growth also in low- and high-tech sector as a whole; however, only high-tech Bangladeshi firms and only low-tech Pakistani firms show results favourable to innovation as a determinant of employment growth. It means that although splitting the sample into low and high technology does not matter as a whole, it shows a significant contribution across countries. This disparity leads us to argue that both countries have some specific policies (of course, according to their own circumstances) regarding innovation pursuance, labour expertise, societal know how of novelties etc., which favour one particular industrial sector or the other. Also recall that 90% Pakistani firms compared with 77% of Bangladeshi ones are low-tech firms, and the very nature of high-tech sector leads public sector policies to favour this sector more in Bangladesh than in Pakistan. In addition, we observe an insignificantly negative impact of labour cost on employment growth throughout, contrary to highly observed significantly negative effect in previous studies. One of the reasons might be that labour in these countries is cheaper compared to developed ones, thereby cost-related fear of a firm to hire new labour force is not as much significant to suppress employment growth. Intermediate input of productivity (raw material) seems to have significantly negative effect on employment change of all low-tech firms, which is more vital in case of Pakistan, suggesting its substitutability with labour, especially for Pakistan. The insignificance of material in case of high-tech firms might be that relatively complex natures of high-tech sectors' production processes do not allow the firms to enhance one particular production factor after sacrificing other. Moreover, our results fail to find this negative effect in case of Bangladesh. The descriptive statistics of raw material and employment, coupled with above mentioned relationships of material and employment, suggest that Pakistani firms rely more on material input while Bangladeshi firms rely more on the latter, for their productivity. Regarding other control variables, we also witness the differences between their performance across countries and across industries, suggesting that the complex nature of employment effect of its determinants is sensitive to NISs of different countries and to different industrial paradigms. Another striking result of our study is that we observe a complementarity between both process and product innovation in order to stimulate employment, suggesting that both should be carried out together in order to induce employment growth.

Unemployment is a curse which has more serious effects in developing countries as compared to the developed world, since developed countries have a series of compensation allowances in terms of social security, unemployment allowance etc., to prevent the involvement of unemployed labour force in destructive activities which can easily destroy the equilibrium of a peaceful society. Hence, to avoid unemployment and its associated consequences in developing countries, it is indispensable for policy makers to initiate and foster policies which could stimulate employment in these countries. Based on our empirical analysis, we strongly recommend the initiation of new and breeding of ongoing innovation projects at micro level and rectification of the problems of NISs of these countries at macro level, in order to circumvent unemployment.

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Tables

Table 1: Variables and their description.

Variables	Descriptions
EGROWTH	Employment growth of full-time permanent workers (2002/03 – 2005/06)
WAGE	Total annual cost of labor per employee (including wages, salaries, bonuses, allowances etc.) in 2005/06 (in log.)
SALES	Total annual sales of a firm in 2005/06 (in log.)
AGE	Age of a firm in years
MATERIAL	Total annual cost of raw material per employee in 2005/06 (in log.)
PRODIN	Ratio of permanent production workers in permanent employment
LBUY	Dummy if a firm's principal buyer is a large firm with more than 100 employees in 2005/06
INDZONE	Dummy if a firm located in industrial zone (park)
ASSET	Dummy if a firm purchases fixed assets (machinery, vehicles, equipments, land, or buildings) in 2005/06.
LICE	Dummy if a firm uses technology licensed from foreign-owned company.
WEB	Dummy if a firm uses website to communicate with its clients or suppliers.
TRAIN	Dummy if a firm runs formal training programs for its permanent employees in 2005/06
UNION	Dummy if a worker union exists in the firm.
PDINN	Dummy if a firm introduces into the market any new or significantly improved product during the last three fiscal years, whether it has or has not a process innovation
PRINN	Dummy if a firm introduces into the market any new or significantly improved production process, including methods of supplying services and ways of delivering products, during the last three fiscal year, whether it has or has not a product innovation
PDPR	Dummy if a firm has both product and process innovations during the last three fiscal years
PDONLY	Dummy if a firm has only product innovation during the last three fiscal years
PRONLY	Dummy if a firm has only process innovation during the last three fiscal years
PAK	Dummy if country is Pakistan

Table 2: Summary statistics.

variables	All	Bangladesh	Pakistan
Permanent employment	199.12	264.39	90.38
Wages per employee (000$)	0.94	0.56	1.58
Age (years)	18.17	16.95	20.20
Material cost per employee (000$)	7.35	5.13	11.09
Purchase of fixed assets (%)	39.27	52.11	17.90
Use of web (%)	25.24	26.13	23.75
Formal training (%)	16.15	21.07	8.59
Large buyer (%)	17.74	23.86	7.48
Workers' union (%)	9.10	11.09	5.79
Production workers intensity (%)	80.60	82.75	77.26
Employment growth (%)	16	22.54	10.02
Product innovation (%)	24.9	33.13	12.32
Process innovation (%)	31.03	44.96	9.60
Both innovations (%)	19.81	27.56	7.84
Only product innovation (%)	5.15	5.58	4.50
Only process innovation (%)	11.27	17.40	1.80

Table 3: Summary statistics for low-and high-tech industries.

variables	All		Bangladesh		Pakistan	
	Low-tech	High-tech	Low-tech	High-tech	Low-tech	High-tech
Permanent employment	202.81	182	280.00	210.96	92.70	68.49
Wage per employee (000$)	0.94	0.91	0.50	0.74	1.58	1.56
Age (years)	17.53	21.15	15.70	21.26	20.14	20.74
Material cost per employee (000$)	6.35	11.87	4.62	6.79	8.80	32.42
Purchase of fixed assets (%)	37.30	48.38	51.04	55.78	38.20	19.74
Use of web (%)	23.74	32.16	24.03	33.33	23.34	27.63
Formal training (%)	13.65	28.24	17.93	32.20	7.95	14.47
Large buyer (%)	19.48	9.73	28.16	9.18	7.01	11.84
Workers union (%)	9.09	9.19	11.84	8.50	5.13	11.84
Production workers intensity (%)	81.43	76.57	84.39	76.94	77.47	75.27
Employment growth (%)	15.77	18.73	22.54	22.57	9.98	10.33
Product innovation (%)	22.01	39.12	29.56	45.83	11.95	15.79
Process innovation (%)	28.14	45.00	42.58	53.41	8.94	15.79
Both innovations (%)	16.41	36.17	23.27	42.80	7.26	13.16
Only product innovation (%)	5.61	2.94	6.30	3.03	4.70	2.63
Only process innovation (%)	11.78	8.82	19.32	10.61	1.71	2.63

Table 4: Probit regressions of PDINN and PRINN for all firms. P-values are in parentheses.

Independent Variables	All		Low-tech		High-tech	
	PDINN	PRINN	PDINN	PRINN	PDINN	PRINN
SALES	0.031	0.102	0.001	0.083	0.177	0.210
	(0.152)	(0.000)	(0.977)	(0.001)	(0.000)	(0.000)
WEB	0.536	0.415	0.556	0.390	0.438	0.515
	(0.000)	(0.000)	(0.000)	(0.000)	(0.022)	(0.009)
ASSET	0.363	0.423	0.370	0.437	0.372	0.446
	(0.000)	(0.000)	(0.000)	(0.000)	(0.026)	(0.009)
PRODIN	-0.442	-0.338	-0.453	-0.443	-0.136	0.417
	(0.056)	(0.148)	(0.096)	(0.099)	(0.766)	(0.375)
INDZONE	0.312	0.414	0.310	0.368	0.479	0.740
	(0.000)	(0.000)	(0.001)	(0.000)	(0.013)	(0.000)
AGE	-0.006	-0.006	-0.007	-0.007	-0.002	-0.004
	(0.033)	(0.018)	(0.023)	(0.032)	(0.681)	(0.490)
LBUY	-0.121	0.043	-0.119	-0.006	0.133	0.658
	(0.204)	(0.644)	(0.248)	(0.949)	(0.649)	(0.045)
PAK	-0.639	-1.224	-0.586	-1.245	-1.090	-1.356
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Intercept	-0.968	-1.460	-0.587	-1.120	-2.865	-3.453
	(0.002)	(0.001)	(0.087)	(0.001)	(0.000)	(0.000)
No. of obs.	1925	1926	1591	1592	334	334
Wald χ^2	285.19	433.95	179.85	327.67	95.33	106.42
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pseudo R^2	0.153	0.241	0.116	0.215	0.265	0.335

Note: All regressions include industry dummies

Table 5: Probit regressions of PDINN and PRINN for Bangladesh. P-values are in parentheses.

Independent Variables	All		Low-tech		High-tech	
	PDINN	PRINN	PDINN	PRINN	PDINN	PRINN
SALES	0.029	0.113	-0.024	0.082	0.189	0.242
	(0.266)	(0.000)	(0.453)	(0.005)	(0.000)	(0.000)
WEB	0.499	0.334	0.548	0.278	0.363	0.530
	(0.000)	(0.001)	(0.000)	(0.015)	(0.072)	(0.010)
ASSET	0.253	0.303	0.241	0.295	0.340	0.429
	(0.003)	(0.000)	(0.016)	(0.002)	(0.054)	(0.019)
PRODIN	-0.332	-0.279	-0.345	-0.460	-0.107	0.747
	(0.227)	(0.311)	(0.309)	(0.168)	(0.823)	(0.134)
INDZONE	0.323	0.404	0.315	0.354	0.403	0.649
	(0.001)	(0.000)	(0.007)	(0.002)	(0.056)	(0.003)
AGE	-0.013	-0.011	-0.019	-0.012	-0.003	-0.008
	(0.000)	(0.001)	(0.000)	(0.006)	(0.606)	(0.197)
LBUY	-0.274	-0.031	-0.256	-0.041	-0.020	0.435
	(0.009)	(0.759)	(0.023)	(0.700)	(0.951)	(0.249)
Intercept	-0.859	-1.432	-0.104	-0.878	-3.107	-4.019
	(0.016)	(0.000)	(0.801)	(0.026)	(0.000)	(0.000)
No. of obs.	1196	1196	933	933	263	263
Wald χ^2	125.35	146.28	66.37	69.89	54.73	67.92
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pseudo R^2	0.094	0.093	0.071	0.056	0.183	0.258

Note: All regressions includes industry dummies

Table 6: Probit regressions of PDINN and PRINN for Pakistan P-values are in parentheses.

Independent Variables	All		Low-tech		High-tech	
	PDINN	PRINN	PDINN	PRINN	PDINN	PRINN
SALES	0.060	0.073	0.066	0.093	0.121	0.068
	(0.142)	(0.156)	(0.129)	(0.097)	(0.469)	(0.573)
WEB	0.668	0.693	0.601	0.691	4.031	2.611
	(0.000)	(0.000)	(0.001)	(0.001)	(0.034)	(0.028)
ASSET	0.626	0.941	0.626	0.984	-1.416	-0.781
	(0.000)	(0.000)	(0.000)	(0.000)	(0.241)	(0.350)
PRODIN	-0.374	-0.177	-0.192	-0.061	-7.420	-3.636
	(0.407)	(0.650)	(0.534)	(0.751)	(0.007)	(0.031)
INDZONE	-0.086	0.160	-0.134	0.049	1.674	1.708
	(0.590)	(0.381)	(0.432)	(0.796)	(0.087)	(0.047)
AGE	0.005	0.004	0.006	0.001	-0.022	0.014
	(0.346)	(0.419)	(0.313)	(0.857)	(0.389)	(0.512)
LBUY	0.734	0.547	0.746	0.415	2.729	2.229
	(0.001)	(0.015)	(0.001)	(0.082)	(0.029)	(0.017)
Intercept	-2.171	-2.966	-2.354	-3.184	-2.131	-1.961
	(0.000)	(0.000)	(0.000)	(0.000)	(0.448)	(0.327)
No. of obs.	726	719	658	648	68	71
Wald χ^2	119.47	123.43	96.18	101.54	14.18	18.88
	(0.000)	(0.000)	(0.000)	(0.000)	(0.077)	(0.026)
Pseudo R^2	0.233	0.354	0.209	0.332	0.660	0.635

Note: All regressions includes industry dummies

Table 7: Employment growth equation for all firms. P values are in parentheses. Dep. var: EGROWTH

Independent variables	All (1)		Low-tech (2)		High-tech (3)	
PDINN	0.323		0.313		0.350	
	(0.004)		(0.019)		(0.035)	
PRINN		0.263		0.256		0.299
		(0.007)		(0.024)		(0.034)
MATERIAL	-0.012	-0.014	-0.011	-0.014	-0.008	-0.008
	(0.100)	(0.069)	(0.137)	(0.089)	(0.719)	(0.736)
WAGE	-0.015	-0.014	-0.016	-0.016	-0.013	-0.011
	(0.333)	(0.340)	(0.332)	(0.331)	(0.734)	(0.774)
LBUY	0.102	0.085	0.099	0.085	0.111	0.083
	(0.001)	(0.007)	(0.002)	(0.008)	(0.324)	(0.481)
AGE	-0.001	-0.001	-0.001	-0.001	-0.003	-0.003
	(0.021)	(0.017)	(0.057)	(0.032)	(0.199)	(0.224)
UNION	-0.054	-0.054	-0.048	-0.050	-0.061	-0.054
	(0.064)	(0.062)	(0.106)	(0.094)	(0.521)	(0.573)
TRAIN	-0.026	-0.024	-0.011	-0.010	-0.095	-0.092
	(0.373)	(0.395)	(0.734)	(0.759)	(0.135)	(0.152)
PAK	-0.045	-0.012	-0.038	0.002	-0.082	-0.086
	(0.198)	(0.779)	(0.309)	(0.964)	(0.295)	(0.245)
Intercept	0.349	0.336	0.342	0.334	0.400	0.387
	(0.000)	(0.000)	(0.001)	(0.001)	(0.085)	(0.097)
No. of obs.	1375	1375	1155	1155	220	220
F-stat.	6.33	6.31	6.55	6.58	2.46	2.49
	(0.000)	(0.000)	(0.000)	(0.000)	(0.009)	(0.008)
coeff. of det.	0.064	0.063	0.063	0.061	0.079	0.078

Note: All regressions includes industry dummies

Table 8: Employment growth equation for Bangladesh. P values are in parentheses. Dep. var: EGROWTH

Independent variables	All (1)		Low-tech (2)		High-tech (3)	
PDINN	0.282		0.231		0.461	
	(0.069)		(0.214)		(0.065)	
PRINN		0.250		0.183		0.329
		(0.063)		(0.267)		(0.076)
MATERIAL	0.008	0.001	0.016	0.009	-0.025	-0.021
	(0.518)	(0.912)	(0.221)	(0.523)	(0.485)	(0.537)
WAGE	-0.022	-0.022	-0.032	-0.032	-0.002	0.003
	(0.524)	(0.529)	(0.468)	(0.467)	(0.968)	(0.962)
LBUY	0.118	0.093	0.120	0.101	0.036	0.009
	(0.003)	(0.013)	(0.011)	(0.016)	(0.687)	(0.926)
AGE	-0.002	-0.002	-0.002	-0.003	-0.002	-0.002
	(0.038)	(0.026)	(0.036)	(0.017)	(0.483)	(0.612)
UNION	-0.019	-0.021	-0.027	-0.029	0.019	0.035
	(0.599)	(0.565)	(0.477)	(0.448)	(0.880)	(0.783)
TRAIN	-0.062	-0.063	-0.051	-0.050	-0.119	-0.114
	(0.088)	(0.077)	(0.242)	(0.241)	(0.072)	(0.091)
Intercept	0.279	0.291	0.297	0.333	0.289	0.230
	(0.114)	(0.099)	(0.200)	(0.142)	(0.384)	(0.484)
No. of obs.	686	686	536	536	150	150
F-stat.	1.79	1.84	1.96	1.94	1.19	1.08
	(0.037)	(0.030)	(0.030)	(0.032)	(0.309)	(0.380)
coeff. of det.	0.038	0.038	0.040	0.038	0.055	0.050

Note: All regressions includes industry dummies

Table 9: Employment growth equation for Pakistan. P values are in parentheses. Dep. var: EGROWTH

Independent variables	All		Low-tech		High-tech	
	(1)		(2)		(3)	
PDINN	0.349		0.346		0.873	
	(0.013)		(0.021)		(0.319)	
PRINN		0.254		0.269		-0.158
		(0.038)		(0.028)		(0.529)
MATERIAL	-0.023	-0.023	-0.025	-0.025	0.021	0.019
	(0.016)	(0.018)	(0.016)	(0.014)	(0.550)	(0.591)
WAGE	-0.014	-0.015	-0.013	-0.014	-0.034	-0.040
	(0.377)	(0.386)	(0.454)	(0.438)	(0.496)	(0.445)
LBUY	0.033	0.077	-0.006	0.045	0.137	0.359
	(0.621)	(0.272)	(0.900)	(0.286)	(0.410)	(0.322)
AGE	-0.001	-0.001	-0.001	$-2.8e^{-04}$	-0.007	-0.003
	(0.235)	(0.402)	(0.314)	(0.733)	(0.344)	(0.496)
UNION	-0.137	-0.147	-0.130	-0.128	0.071	-0.198
	(0.003)	(0.002)	(0.009)	(0.011)	(0.807)	(0.191)
TRAIN	0.051	0.068	0.060	0.066	-0.553	0.217
	(0.288)	(0.144)	(0.216)	(0.172)	(0.450)	(0.326)
Intercept	0.369	0.376	0.372	0.382	0.203	0.045
	(0.009)	(0.010)	(0.012)	(0.012)	(0.602)	(0.884)
No. of obs.	686	679	619	609	67	70
F-stat.	1.79	1.92	1.77	1.92	0.39	0.85
	(0.041)	(0.025)	(0.056)	(0.040)	(0.924)	(0.576)
coeff. of det.	0.044	0.049	0.041	0.042	0.186	0.144

Note: All regressions includes industry dummies

Table 10: Employment growth equation for all firms using innovation variables different from Table (7). P values are in parentheses. Dep. var: EGROWTH

Independent variables	All			Low-tech			High-tech		
	(1)			(2)			(3)		
PDPR	0.308			0.294			0.331		
	(0.005)			(0.026)			(0.035)		
PDONLY		0.533			0.746			-0.059	
		(0.396)			(0.290)			(0.959)	
PRONLY			0.180			0.209			0.270
			(0.533)			(0.537)			(0.816)
MATERIAL	-0.013	-0.003	-0.007	-0.012	-0.002	-0.008	-0.007	0.008	0.007
	(0.083)	(0.734)	(0.363)	(0.114)	(0.792)	(0.314)	(0.751)	(0.705)	(0.738)
WAGE	-0.015	-0.013	-0.013	-0.016	-0.015	-0.016	-0.014	-0.002	-0.002
	(0.321)	(0.396)	(0.374)	(0.324)	(0.363)	(0.342)	(0.722)	(0.966)	(0.963)
LBUY	0.099	0.110	0.093	0.095	0.109	0.090	0.113	0.140	0.108
	(0.002)	(0.000)	(0.016)	(0.003)	(0.001)	(0.017)	(0.312)	(0.201)	(0.633)
AGE	-0.001	-0.002	-0.002	-0.001	-0.001	-0.002	-0.003	-0.002	-0.002
	(0.019)	(0.016)	(0.012)	(0.050)	(0.023)	(0.013)	(0.197)	(0.344)	(0.404)
UNION	-0.054	-0.039	-0.043	-0.049	-0.038	-0.042	-0.060	-0.017	-0.021
	(0.063)	(0.170)	(0.132)	(0.105)	(0.199)	(0.150)	(0.524)	(0.858)	(0.817)
TRAIN	-0.028	0.001	$-4.7e^{-04}$	-0.012	0.011	0.009	-0.096	-0.049	-0.051
	(0.349)	(0.969)	(0.986)	(0.722)	(0.722)	(0.766)	(0.134)	(0.426)	(0.394)
PAK	-0.045	-0.104	-0.072	-0.037	-0.095	-0.047	-0.096	-0.191	-0.170
	(0.192)	(0.000)	(0.170)	(0.327)	(0.001)	(0.490)	(0.200)	(0.006)	(0.024)
Intercept	0.371	0.326	0.344	0.365	0.320	0.352	0.416	0.292	0.272
	(0.000)	(0.003)	(0.001)	(0.000)	(0.008)	(0.001)	(0.077)	(0.234)	(0.261)
No. of obs.	1375	1375	1375	1155	1155	1155	220	220	220
F-stat.	6.30	6.39	6.54	6.56	6.69	7.02	2.44	2.20	2.16
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.009)	(0.019)	(0.022)
coeff. of det.	0.064	0.056	0.056	0.062	0.056	0.056	0.078	0.065	0.065

Note: All regressions includes industry dummies

Table 11: Employment growth equation for Bangladesh using innovation variables different from Table (8). P values are in parentheses. Dep. var: EGROWTH

Independent variables	All (1)			Low-tech (2)			High-tech (3)		
PDPR	0.282 (0.055)			0.235 (0.209)			0.423 (0.061)		
PDONLY		-0.403 (0.515)			-0.226 (0.726)			-0.822 (0.515)	
PRONLY			0.105 (0.841)			-0.180 (0.715)			0.661 (0.400)
MATERIAL	0.005 (0.706)	0.009 (0.477)	0.011 (0.451)	0.013 (0.332)	0.014 (0.326)	0.020 (0.257)	-0.025 (0.481)	-0.002 (0.959)	0.002 (0.951)
WAGE	-0.024 (0.486)	-0.019 (0.574)	-0.016 (0.635)	-0.034 (0.442)	-0.033 (0.460)	-0.032 (0.467)	-0.003 (0.957)	0.009 (0.879)	0.012 (0.835)
LBUY	0.110 (0.005)	0.091 (0.016)	0.094 (0.118)	0.112 (0.012)	0.098 (0.021)	0.115 (0.053)	0.042 (0.636)	0.068 (0.407)	-0.026 (0.844)
AGE	-0.002 (0.023)	-0.003 (0.004)	-0.003 (0.008)	-0.002 (0.024)	-0.003 (0.004)	-0.003 (0.004)	-0.002 (0.478)	-0.001 (0.635)	$-2.6e^{-05}$ (0.994)
UNION	-0.023 (0.544)	-0.017 (0.651)	-0.014 (0.699)	-0.029 (0.445)	-0.028 (0.467)	-0.026 (0.502)	0.015 (0.902)	0.070 (0.581)	0.065 (0.579)
TRAIN	-0.065 (0.076)	-0.050 (0.154)	-0.048 (0.162)	-0.054 (0.227)	-0.042 (0.307)	-0.041 (0.313)	-0.120 (0.071)	-0.086 (0.210)	-0.089 (0.186)
Intercept	0.328 (0.064)	0.354 (0.064)	0.279 (0.132)	0.341 (0.131)	0.398 (0.088)	0.376 (0.097)	0.319 (0.350)	0.191 (0.606)	0.025 (0.936)
No. of obs.	686	686	686	536	536	536	150	150	150
F-stat.	1.77 (0.039)	1.64 (0.063)	1.96 (0.019)	1.96 (0.030)	1.93 (0.034)	2.17 (0.015)	1.16 (0.327)	0.65 (0.753)	0.69 (0.714)
coeff. of det.	0.039	0.033	0.033	0.040	0.036	0.036	0.055	0.034	0.036

Note: All regressions includes industry dummies

Table 12: Employment growth equation for Pakistan using innovation variables different from Table (9). P values are in parentheses. Dep. var: EGROWTH

Independent variables	All (1)			Low-tech (2)		
PDPR	0.307 (0.016)			0.300 (0.022)		
PDONLY		1.474 (0.286)			1.054 (0.518)	
PRONLY			0.643 (0.223)			0.822 (0.124)
MATERIAL	-0.022 (0.017)	-0.019 (0.062)	-0.023 (0.013)	-0.025 (0.015)	-0.020 (0.041)	-0.023 (0.019)
WAGE	-0.016 (0.353)	-0.014 (0.370)	-0.012 (0.492)	-0.014 (0.422)	-0.012 (0.458)	-0.014 (0.444)
LBUY	0.068 (0.282)	0.018 (0.891)	0.075 (0.069)	0.037 (0.375)	-0.012 (0.934)	0.091 (0.040)
AGE	-0.001 (0.469)	-0.001 (0.454)	$-6.8e^{-05}$ (0.933)	$-4.1e^{-04}$ (0.631)	-0.001 (0.581)	$4.1e^{-04}$ (0.636)
UNION	-0.138 (0.003)	-0.110 (0.015)	-0.108 (0.017)	-0.131 (0.009)	-0.083 (0.057)	-0.097 (0.035)
TRAIN	0.061 (0.197)	0.083 (0.075)	0.103 (0.018)	0.070 (0.142)	0.099 (0.033)	0.088 (0.059)
Intercept	0.377 (0.009)	0.310 (0.016)	0.358 (0.013)	0.381 (0.011)	0.318 (0.016)	0.361 (0.015)
No. of obs.	676	664	634	609	619	609
F-stat.	1.88 (0.034)	1.60 (0.088)	1.88 (0.033)	1.92 (0.040)	1.58 (0.101)	1.87 (0.047)
coeff. of det.	0.044	0.036	0.044	0.042	0.032	0.038

Note: All regressions includes industry dummies

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